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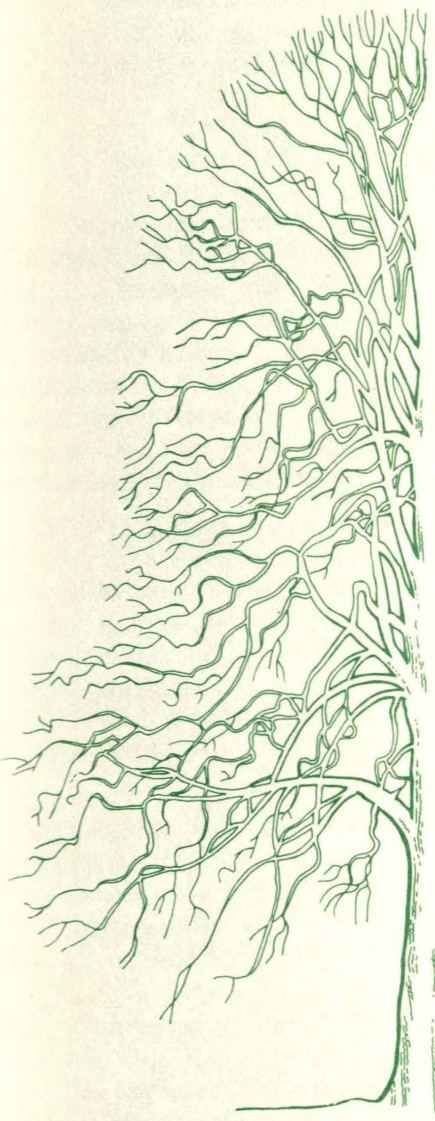

The economic and geographic **IMPACT** of national forest land on counties in southern Illinois

David Spencer
and
Ronald I. Beasley

rth Central Forest Experiment Station
orest Service, U.S. Department of Agriculture

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North Central Forest Experiment Station
Robert A. Hann, Director
Forest Service—U.S. Department of Agriculture
1922 Folwell Avenue
St. Paul, Minnesota 55108

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THE ECONOMIC AND GEOGRAPHIC IMPACT OF NATIONAL FOREST LAND ON COUNTIES IN SOUTHERN ILLINOIS

David Spencer, *Executive Director,*
Two Rivers Regional Council of Public Officials,
Quincy, Illinois
(Formerly Research Assistant, Department of Geography,
Southern Illinois University, Carbondale, Illinois)
and **Ronald I. Beazley,** *Professor,*
Department of Geography,
Southern Illinois University,
Carbondale, Illinois

The USDA Forest Service is concerned with the possibility of negative economic effects of National Forests on local economies. Legislation has been introduced repeatedly in recent years seeking to change the present method of revenue sharing with State and local governments. The reason is that tax losses to local government supposedly occur as a result of the tax immunity of federal land.[1]

The purpose of this study was to explore the relation of public land to a local economy; the results have implications for the broader problem. The study region was southern Illinois, the public land, the Shawnee National Forest. Other types of public land in southern Illinois, such as the 44,000-acre Crab Orchard Wildlife Refuge, were considered only peripherally.

Assessing the relative economic effects of public land is difficult because data are hard to gather and measure consistently. However, some conclusions were reached that shed light on the regional issue and will perhaps contribute to the resolution of this problem nationally.

[1]*The House Committee on Insular Affairs held hearings on this subject during the summer of 1974. At that time 14 bills had been introduced that would change revenue-sharing systems on Federal land. Since that time, several more bills have been introduced, most notably H.R. 9719, which would give local government a choice between a minimum payment per acre or revenue-sharing payments.*

THE STUDY SCOPE

The geographic focus was the 11-county area comprising the southern tip of Illinois. Ten of the 11 counties contain areas of the Shawnee National Forest of varying size. The eleventh county, Pulaski, is not within the purchase area of the forest; however, it is included as a control since it is similar in all other respects. The 11 counties are Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union, and Williamson. The study region (fig. 1) is largely rural, bounded on two sides by the Ohio and Mississippi Rivers; it covers roughly 3,748 square miles. The terrain consists primarily of unglaciated hill country, which gives way in the larger river valleys to low gravel hills and swampy, forested bottomland.

The economy of the region depends primarily on mining, agriculture, some manufacturing, and the presence of several large institutions, including a state university, two prisons, and a large state hospital.

Purchase of land for the Shawnee National Forest (fig. 2) was begun in 1933; about 87 percent of the land was purchased before World War II (Callahan *et al.* 1974). The forest presently contains 254,167 acres, of a total of 839,735 acres within the purchase area.

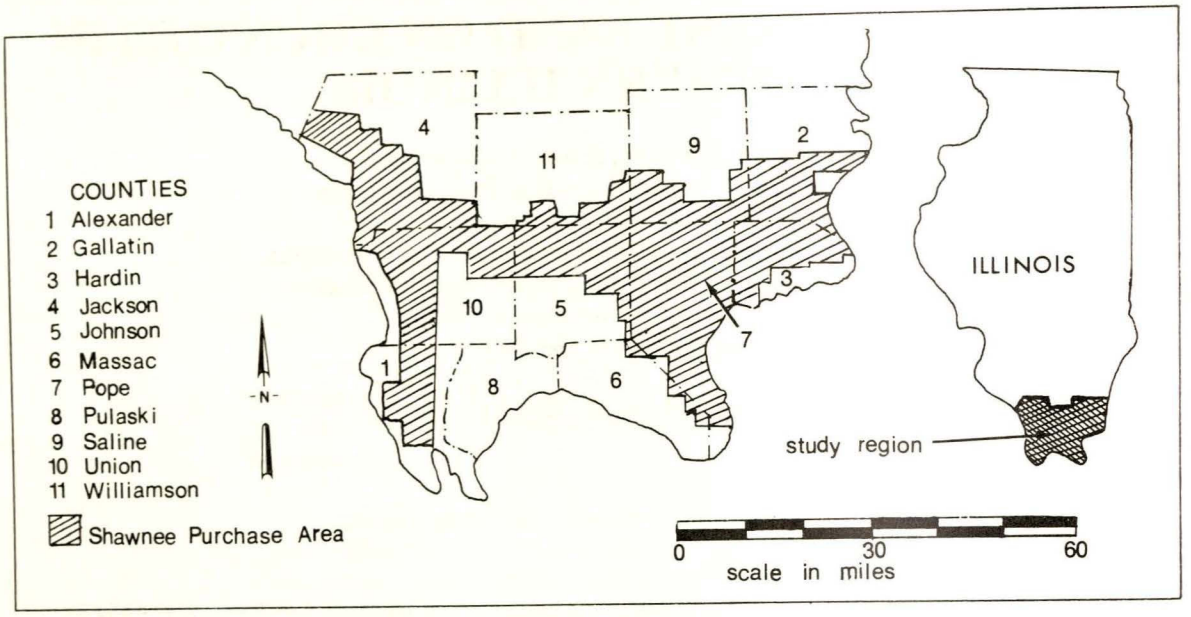

Figure 1. — *The study region.*

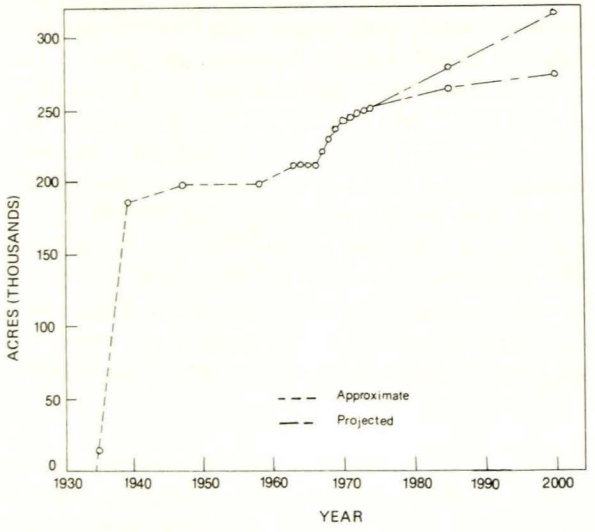

Figure 2. — *Land acquisition on the Shawnee National Forest (Callahan* et al. *1974).*

At present some counties are resisting further purchases by the Forest Service because they contend that removal of land from the tax rolls and other negative economic effects are seriously affecting the general economic welfare of the region — this belief relates, in part, to the National Forest revenue-sharing program. The revenue of the Shawnee National Forest is low compared with other National Forests, and as a result of this, revenue sharing funds are low. The reason, according to Callahan *et al.* (1974), is that "land ownership is scattered and the emphasis on timber production is low, while the emphasis on recreation and wildlife activities which tend to be non-revenue generating is high."

Of the 10 counties within the purchase area, Pope County has the largest percentage of its area in National Forest and has received the most attention both locally and nationally. For example, in an NBC news program aired in 1975, local residents blamed the presence of the National Forest for a variety of county ills, ranging from insolvency of the county government to an increase in coyote populations causing destruction of livestock. In October of 1975 the Illinois Legislature passed an emergency loan of $140,000 so that the County could pay its 1975 tax fiscal-year bills. William Leach, Assistant County Commissioner, said in an interview in October, 1975: "The County corporate fund has an annual deficit of $150,000 . . . Alternative solutions are a new taxation, a State cost-sharing program for County programs, or authorization for Federal in-lieu-of tax payments of $1.50 per acre." These sentiments are echoed throughout the region by State and local officials and by many members of the public.

In spite of the above, the degree of contribution, if any, of the National Forest to these problems has not been established. The intent of this study was to evaluate the gains and losses to the people of southern Illinois resulting from land acquisition by the Forest Service, and to assess the economic impact of the Forest in its present condition.

To meet these objectives, the problem was approached from two perspectives. First, the socioeconomic structure of the study region was explored, with special emphasis on how the Shawnee National Forest interacts with this structure. Second, specific effects of the National Forest on county finances were analyzed.

Three hypotheses were constructed and tested to meet the objectives:

1. The socioeconomic structure of southern Illinois is sufficiently homogeneous to be analyzed systematically.
2. The Shawnee National Forest has a significant effect on the socioeconomic structure of the region.
3. The Shawnee National Forest has a negative effect on individual welfare, regional economic welfare, and local governmental welfare in southern Illinois.

STATISTICAL METHODS OF ANALYSIS

The Data Base

Socioeconomic data were collected on 26 variables for each county in the study region. (A complete list appears in Appendix A.) Most of the data were compiled from United States Census material, which represents the most current information available. Success in obtaining observations on each variable was generally high and thus few cases of missing data exist.[2]

[2]*It should be noted that the number of observations on each variable is rather small (11 per variable, corresponding to the 11 counties). This, however, is not a sampling problem because these observations have been taken on the total population of counties in the region. The 11 counties studied do not represent a larger population of counties outside the study region, therefore the population of 11 counties is a total enumeration.*

Steps in Analysis

The raw data collected were assimilated in two steps. In the first step the data were compiled visually and graphically to ascertain how the counties stand in relation to one another on a variable-by-variable basis. Along with this cross-county analysis, an intercorrelation matrix of 17 variables was constructed using a Spearman rank correlation procedure (see Appendix B, table 1). This intercorrelation matrix was further modified using partial correlation analysis to eliminate variables that measure the same attributes or mask relations among other variables (see table 1).

It became apparent during this analysis that while some insights into the socioeconomic structure of southern Illinois were being obtained, this approach was not providing the most useful information overall. It was felt that multiple factor analysis could "collapse" the shared variance of the most meaningful variables into several recognizable dimensions that would be more useful. Hence, the second step in the data interpretation: a multiple factor analysis.

The factor analysis was done to determine the variations in economic welfare among counties and to show these factors visually, in a form that could be compared against the distribution of Forest Service land.

A factor may be defined as a vector of interrelation among several variables that are associated with the factor positively or negatively and that exhibit variable strengths of relation to that vector. These measures of relation of the factor to each variable are called "loadings". Thus, in describing a factor, those variables upon which it "loads" most highly indicate to some extent the nature and character of that factor. The intercorrelation matrix was analyzed using Rao's Canonical Factor Analysis with an oblimin rotation. Factor scores were then produced for each factor on all observations. Factor scores measure the strength of relation of each factor to each observation, in this case to counties. The results were used to map the factors in relation to the distribution of Forest Service land. This mapping process was accomplished using a SYMAP program (the quantitative methods used are discussed in detail in Appendices B and C).

Table 1. — *Intercorrelations of variables used in factor analysis*

	Variable	V_1	V_2	V_6	V_9	V_{11}	V_{17}	V_{19}	V_{21}	V_{23}	V_{26}
V_1	County population, 1970	1.0	0.80	−0.55	0.78	0.52	0.88	0.94	0.97	−0.33	0.76
V_2	Mean county income, 1970	.80	1.0	−.88	.77	.66	.73	.78	.75	−.32	.66
V_6	Percentage of the county population below the U.S. poverty level, 1970	−.55	−.88	1.0	−.63	−.56	−.47	−.57	−.54	.35	−.45
V_9	County area in acres	.78	.77	−.63	1.0	.70	.58	.73	.65	.003	.53
V_{11}	Number of acres classified as tillable in the county, 1969	.52	.66	−.56	.70	1.0	.40	.50	.37	−.32	.38
V_{17}	Number of manufacturing plants employing more than 20 people, 1972	.88	.73	−.47	.58	.40	1.0	.82	.92	−.39	.78
V_{19}	Median school years completed, 1970	.94	.78	−.57	.73	.50	.82	1.0	.93	−.34	.69
V_{21}	Total county tax revenues, 1972	.97	.75	−.54	.65	.37	.92	.93	1.0	−.38	.78
V_{23}	Percentage of county area in National Forest	−.33	−.32	.35	.003	−.32	−.39	−.34	−.38	1.0	−.23
V_{26}	Total per capita county retail sales, 1972	.76	.66	−.45	.53	.38	.78	.69	.78	−.23	1.0

Results of the Factor Analysis

The initial comparisons between variables, described above, indicated that a wide disparity in resources, wealth, and economic activity exists among the 11 counties in the study area. For example, more than 50 percent of the total property taxes of all 11 counties are collected in two Counties, Jackson and Williamson. The economically marginal nature of several other counties in the study area does not, however, necessarily correspond to greater amounts of Forest Service land. Jackson County has a relatively high level of economic welfare and also the second greatest amount of Forest Service land. Pulaski County, which has no National Forest lands, has one of the lowest levels of economic welfare. These circumstances indicate that there are more complex, underlying reasons for the National Forest's apparent association with economic problems in certain counties. The factor analysis was a necessary procedure in delineating these complex relations.

In this section each factor identified in the analysis is discussed and a computer-generated map of the theoretical distribution of that factor is presented. It should be noted that the results are not absolute in any sense, and the factors and maps are simply tools to help understand a complex situation. The inclusion of more variables might change the analysis somewhat, but probably not substantially. The variables used can be considered representative and capable of bringing into focus some of the major economic forces operating in the study region. The rotated factor loadings are presented in table 2.

Factor One: Urban Economic Activity

This factor has a strong positive association with total county population, manufacturing, total tax revenue, and retail sales. Because it relates strongly to high population and sophisticated economic activity this is an urban factor. It shows little association with tillable acreage, indicating that it is not related to agriculture, and further reinforcing the urban nature of the factor. The tabulation below shows the relations of factor one to each variable, expressed as factor loadings:

Table 2. — *Rotated oblique factor pattern loadings*

Variable		Factors indentified by numbers and descriptive name				
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
		Urban economic activity	Individual income	Density of National Forest ownership	Educational opportunity	Agricultural intensity
V_1	County population, 1970	0.445	0.035	−0.052	0.487	0.165
V_2	Mean county income, 1970	.332	.677	−.021	−.026	.147
V_6	Percentage of the population below the U.S. poverty level, 1970	.073	−1.024	.045	.021	.017
V_9	County area in acres	.086	−.190	.353	.349	.568
V_{11}	Number of acres classed as tillable in the county, 1969	−.013	.010	.112	−.051	.947
V_{17}	Number of manufacturing plants employing more than 20 workers, 1972	1.088	−.049	−.041	−.130	.032
V_{19}	Median school years completed, 1970	.241	.131	.137	.622	.091
V_{21}	Total county tax revenues, 1972	.588	.089	−.110	.420	−.069
V_{23}	Percentage of county area in National Forest	−.045	−.059	.851	−.040	−.076
V_{26}	Total per capita retail sales, 1971	.754	.096	.024	.001	−.003

Variable		Loadings of factor one, urban economic activity
V_1	County population, 1970	0.445
V_2	Mean county income, 1970	.332
V_6	Percentage of the population below the U.S. poverty level, 1970.	.073
V_9	County area in acres	.086
V_{11}	Number of acres classed as tillable in the county, 1969	−.013
V_{17}	Number of manufacturing plants employing more than 20 workers, 1972	1.088
V_{19}	Median school years completed, 1970	.241
V_{21}	Total county tax revenues, 1972	.588
V_{23}	Percentage of county area in National Forest	−.045
V_{26}	Total per capita retail sales.	.754

Of most interest to this study is the extremely low loading on the National Forest variable. This variable has the highest negative value, indicating that while the National Forest's effect on urbanization is relatively neutral, National Forest Land and urbanization are generally not compatible. In effect, as urbanization increases so does the intensity of land use, resulting in land less suited to the extensive management the Forest Service practices. This is illustrated by a similar loading for agriculture (variable 11). The effect of extensive versus intensive land use is also important to the factor's relation with agriculture.

The factor map (fig. 3) is based on a standardized factor score for each county. This score was placed at the point of highest population in the county (in most cases the county seat); the resultant map gives some indication of the intensity of this factor throughout the study region (see Appendix C for details of mapping procedure).

Areas appearing darkest on the map are the most urban and have the highest levels of economic activity. Only Jackson and Williamson Counties fall into the strongly urban category. Massac, Saline, Union, and Alexander Counties are primarily semi-rural counties with an intermediate amount of economic activity. Hardin, Pope, Gallatin, Johnson, and Pulaski Counties are completely rural counties, and have relatively low levels of economic activity. This factor accounts for 66.4 percent of the variance among the counties on these variables. The low loading on the variable measuring the influence of the National Forest is important with respect to this factor. The factor itself strongly indicates that the degree of

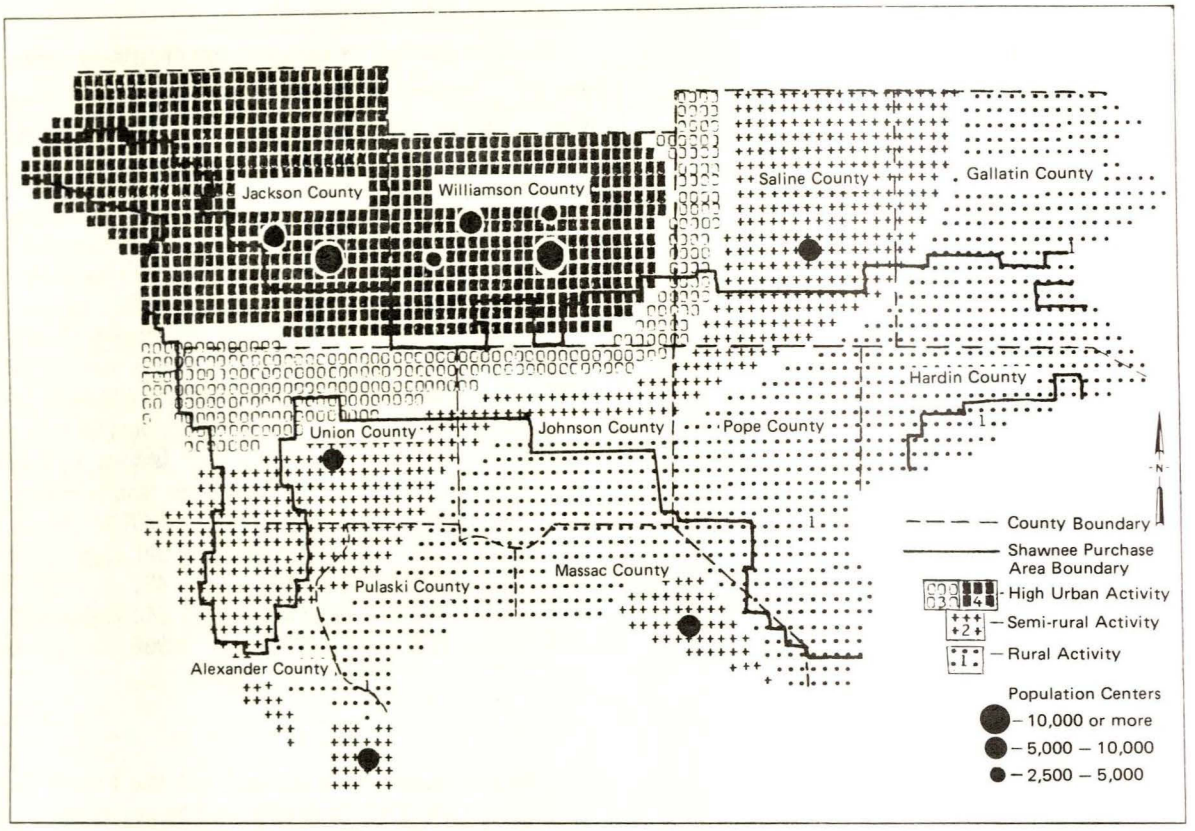

Figure 3. — *Factor one – urban economic activity.*

urbanization present in a particular county is the overriding characteristic in determining levels of economic activity. This factor accounts for a large portion of the differences in economic welfare and opportunity among the counties in association with a degree of urbanization. Thus, this factor is the most important consideration in determining whether a county is a viable economic unit. It follows then, that because there is very low interaction between the National Forest and this factor, the presence of the National Forest is not a major variable influencing levels of economic activity in various counties in the region.

Factor Two: Individual Income

This factor is directly related to individual welfare in the study region. It loads most highly on mean income and percentage of the county population below the poverty level. The factor does not load importantly on any other variables, including presence of the National Forest. This indicates that the National Forest is generally a neutral variable in determing individual economic welfare in the region, as measured by income and poverty level.

The factor map (fig. 4) was constructed by placing a factor score at the point of highest population in the county. The map clearly delineates two pockets of poverty in the region. One lies within the Shawnee National Forest boundaries in Pope and Hardin Counties. A second more extensive area is centered south of the Forest in Alexander and Pulaski Counties. The marked areas of high and intermediate income are much larger than the preceding factor would lead one to believe. This probably reflects the ability in some of the more rural counties to commute to the urbanized areas for employment.

The extensive pocket of poverty in Alexander and Pulaski Counties appears to be statistically related to the presence of a large black population in these counties. Blacks make up 28 percent of the population in Alexander County and 32 percent in Pulaski County. Appoximately 60 percent of the

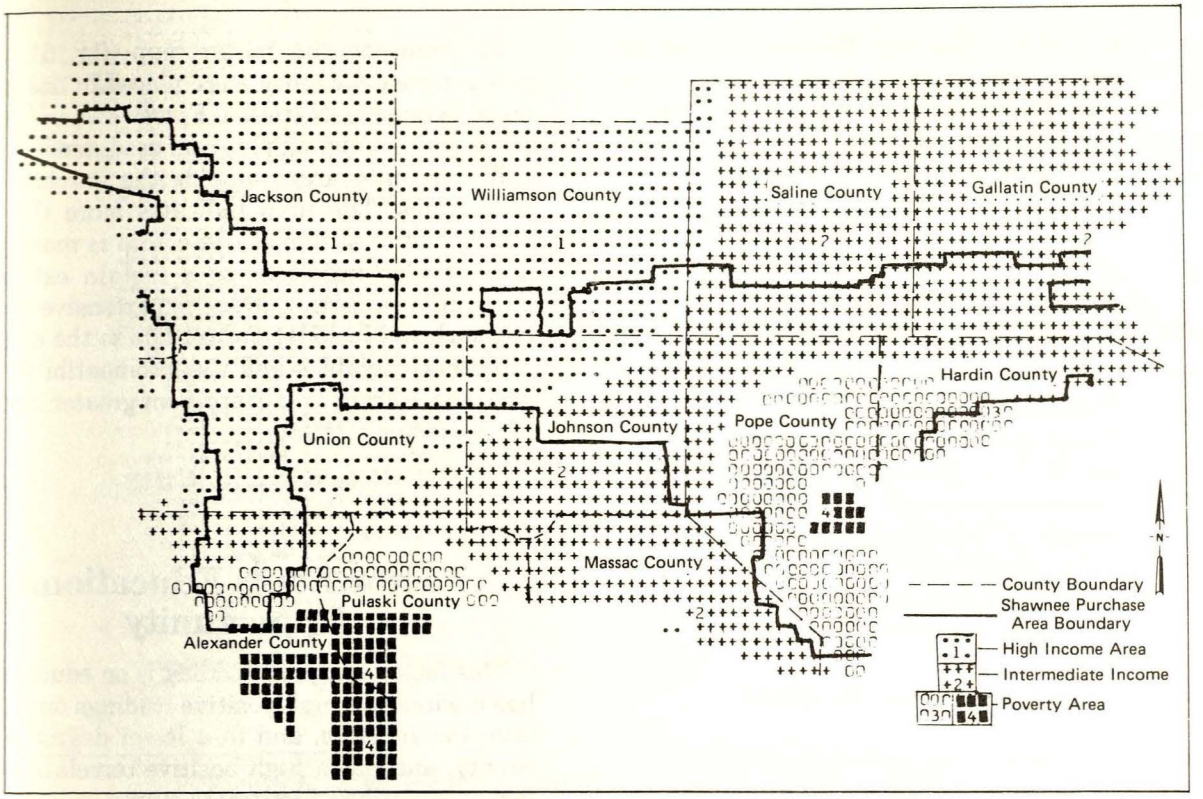

Figure 4. — *Factor two – individual income.*

blacks in these two counties had incomes below the poverty level according to the 1970 census. While the reasons for these conditions appear to be outside the scope of this study, they can generally be attributed to a changing economy, lack of opportunity, probable discrimination, and other common causes of rural poverty. The problem of black poverty in southern Illinois is also related to some extent to a larger regional problem that extends beyond the boundaries of the study area. This area includes northwestern Kentucky, western Tennessee, and especially the "boot-heel" area of southeastern Missouri directly across the Mississippi River from the counties in question. Southeastern Missouri in particular has been well documented as having some of the worst rural, black poverty in the nation. The point is, this particular situation has widespread causes that are not particularly related to the presence of the National Forest.

Explaining the poverty area in Pope and Hardin Counties is more difficult. Two conditions appear to contribute highly to this situation: remoteness from regional employment centers and extremely marginal agriculture. The fact that large amounts of National Forest also exist in these counties appears to be an outgrowth of these same economic conditions rather than the cause of them. In conjunction with the previous factor description, a pattern emerges which points to an apparent relation between the density of National Forest ownership and a marginal economy. This appears to be a coincidental structural relation.

Thus, in simple terms it appears that this factor and the previous one point to the notion that the presence of a low level of economic welfare with a high density of National Forest ownership may arise out of common conditions, rather than one being the cause of the other.

Factor Three: Density of National Forest Ownership

Factor three has a high positive loading on the percentage of county area in National Forest, a low loading on county size, and negligible association with the remaining variables. This factor pattern to a large extent confirms the previous

suggestion that the Shawnee National Forest is not the cause of low levels of eonomic welfare in southern Illinois. The factor loadings on each variable are tabulated below to emphasize the lack of importance of most of them to this factor.

Variable		Loadings of factor three, density of National Forest ownership
V_1	County population, 1970	−0.052
V_2	Mean county income, 1970	.021
V_6	Percentage of the population below the U.S. poverty level, 1970.	.045
V_9	County area in acres	.343
V_{11}	Number of acres classed as tillable in the county, 1969.	−.112
V_{17}	Number of manufacturing plants employing more than 20 workers, 1972.	−.041
V_{19}	Median school years completed, 1970.	−.137
V_{21}	Total county tax revenues, 1972	−.110
V_{23}	Percentage of county area in National Forest.	.851
V_{26}	Total per capita retail sales, 1971	.024

The loadings of county area and percentage of National Forest by county represent a composite variable or factor that we have called "density of National Forest ownership". It measures both the amount of National Forest and also the proportion of National Forest by counties, primarily the latter. These two variables are not correlated in a simple sense, as table 1 shows. Percentage of National Forest in counties may be high, medium or low, irrespective of county size, but on the average, county size reflects amount or area of National Forest. Hence, the larger the county, on the average, the larger is the area of National Forest (not the percentage). So both the amount of National Forest and its proportion by counties are reflected by the factor, which is a comprehensive measure of National Forest. This type of result is one of the useful features of factor analysis.

The remaining variables, which in one way or another reflect economic characteristics, show negligible association with the presence of National Forest.

To generate the factor map (fig. 5), factor scores for each county were placed in the area of most extensive National Forest ownership. Because of the mapping program used, densities may spill over into areas outside the purchase area boundaries. The map indicates more than just where National Forest ownership is most extensive; it also indicates to a certain extent the suitability of certain areas for extensive types of use such as National Forest, due to the effects of the other variables and their compatibility with such use. Darker areas represent greater intensity of this factor.

Factor Four: Educational Opportunity

This factor's highest loading is on education. It has moderately high positive loadings on population, tax revenue, and to a lesser degree size of county, and has a high positive correlation with factor one, urban economic activity.

The map (fig. 6) was generated by placing factor scores in the population center in each county. The darker areas (Jackson and Williamson Counties) are the counties having high educational levels and strong educational opportunities. These counties have relatively high levels of economic activity and are generally the most capable of supporting county government, supplying services, and providing educational opportunity. Educational levels and opportunity drop sharply in the remaining counties. Saline and Pope Counties have moderate educational opportunities, with the remaining counties primarily at the bottom of the scale.

Somewhat surprisingly, Pope County ranks above its counterparts in educational opportunity. It might be expected that low population density and limited economic activity in Pope County would work to the detriment of education. However, the fact that over one-third of the county is in National Forest ownership may mean that more money is available for education, since the county in effect has a smaller land area over which wealth and government services must be extended. In a sense, the National Forest may have zoned Pope County to its own benefit.

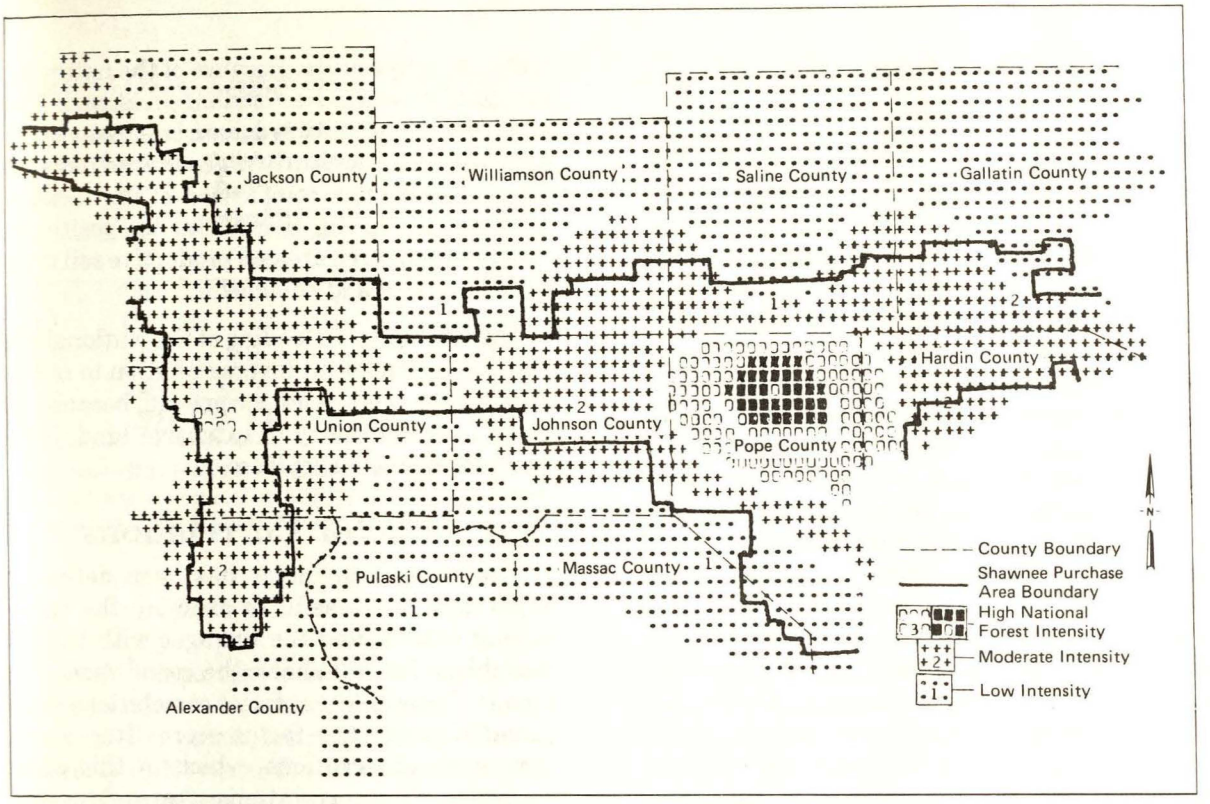

Figure 5. — *Factor three – density of national forest ownership.*

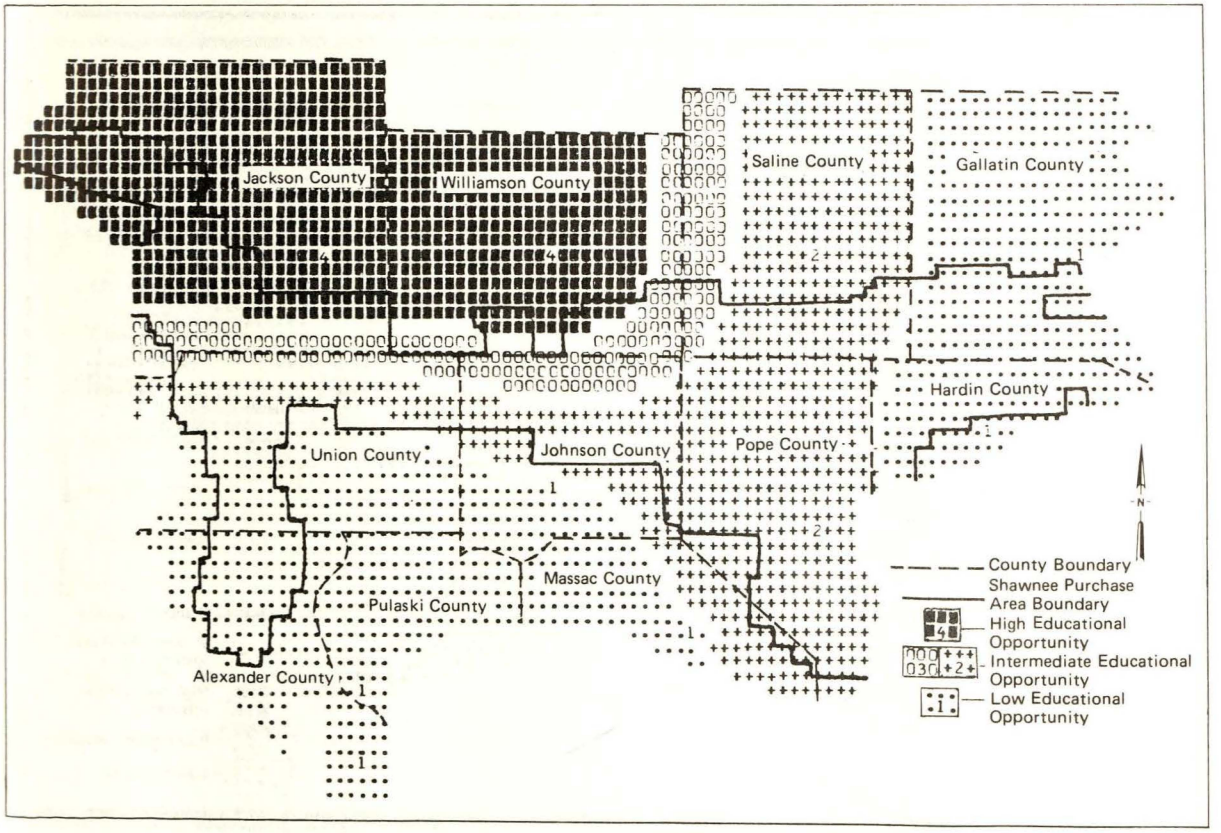

Figure 6. — *Factor four – educational opportunity.*

Factor Five: Agricultural Intensity

This factor loads highly on tillable acreage and moderately on county size. The loadings on the remaining variables are neutral and not significant, including the National Forest variable. This factor reflects primarily the great disparity in agricultural opportunity in the study region, due primarily to highly variable soil and topography. The agricultural variable used was the number of tillable acres in each county; therefore, the results favor row cropping over other types of agriculture, such as fruit and livestock, which may be important in certain localities. However, this variable was chosen because it best reflects the direct productivity of soil and topography.

As seen on the map (fig. 7), only Jackson County has a large potential for highly intensive agriculture. Intermediate potential exists in Union, Saline, and Gallatin Counties, with the remaining counties possessing only marginal agricultural resources. It should be remembered that this map represents the strength of the relation of the factor to each county. Because of the nature of the mapping process, the distribution at each level of intensity of agriculture does not necessarily represent where agriculture *in general* actually takes place. However, a comparison of the factor map with a soil map (fig. 8) confirms the positive relation between large areas of productive soil in particular counties and this factor.

The low negative loading of the National Forest variable suggests an inverse relation to intensive agriculture. This is not surprising, because of the basic incompatibility of extensive land use with more intensive agriculture.

Factor Correlations

Now that each factor has been defined and explained, it is useful to examine the relations among factors, and the linkages with individual variables. Table 3 shows the correlations among factors. Because these factor correlations are computed through the factor scores (the scores of factors on observations, which in this case are counties), the correlations also reflect spatial associations.

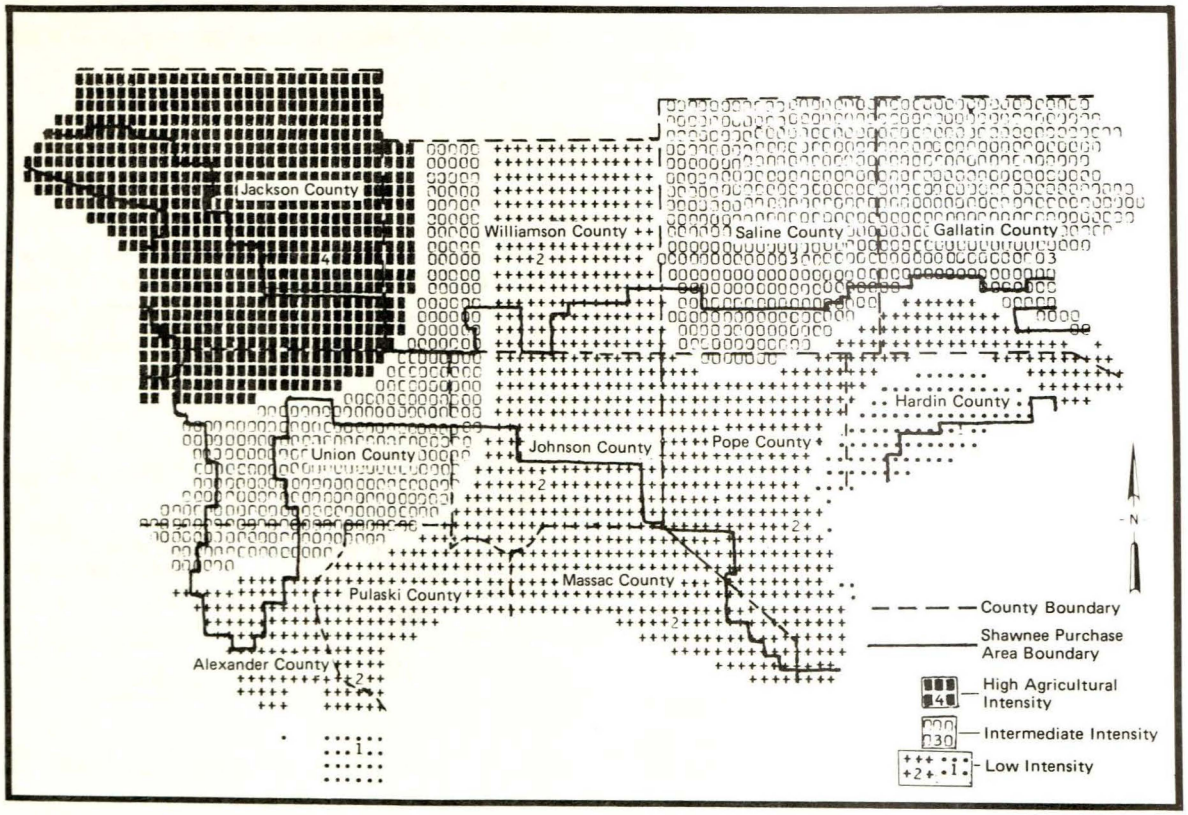

Figure 7. — *Factor five – agricultural intensity.*

Table 3. — *Oblique factor intercorrelations*[1]

	Urban economic activity	Individual income	Density of National Forest ownership	Educational opportunity	Intensive agriculture
	F_1	F_2	F_3	F_4	F_5
F_1	1.0	0.57	−0.24	−0.76	0.44
F_2	−.57	1.0	.19	−.46	−.62
F_3	−.24	−.19	1.0	−.02	−.13
F_4	.76	.46	−.02	1.0	−.39
F_5	.44	.62	−.13	−.39	1.0

[1]These are moderate correlations among factors because the program used was a particular oblimin rotation, which permits oblique factors (interdependent) but does not tend to overlap the factors.

Perhaps most important is the relation of factor three to the others; however, the reader may wish to scan the others for consistency. Factor three (density of National Forest ownership) has the lowest correlations with every other factor, while factor one, urban economic activity, shows a strong relation to the other factors. Factors two and four are primarily direct measures of individual welfare, while factors one and five represent economic activity from which economic welfare inferences may be drawn.

The low correlations between factor three and the others indicates, as the preceding analysis did, that the National Forest has very little if any interaction with economic activity in the region. In areas of the region where a high density of public land coincides with low economic activity, it is due primarily to common causes such as poor farmland, lack of urban economic activity, or other conditions which produce low-intensity land use. These conditions result in land predisposed toward extensive use such as National Forest. Factor one largely depicts individual welfare (measured by income and education) and where wealth is concentrated. This in turn supports viable county government and educational opportunity through a large tax base. This factor in association with factor five (agriculture) determines almost completely the economic well-being of a particular county.

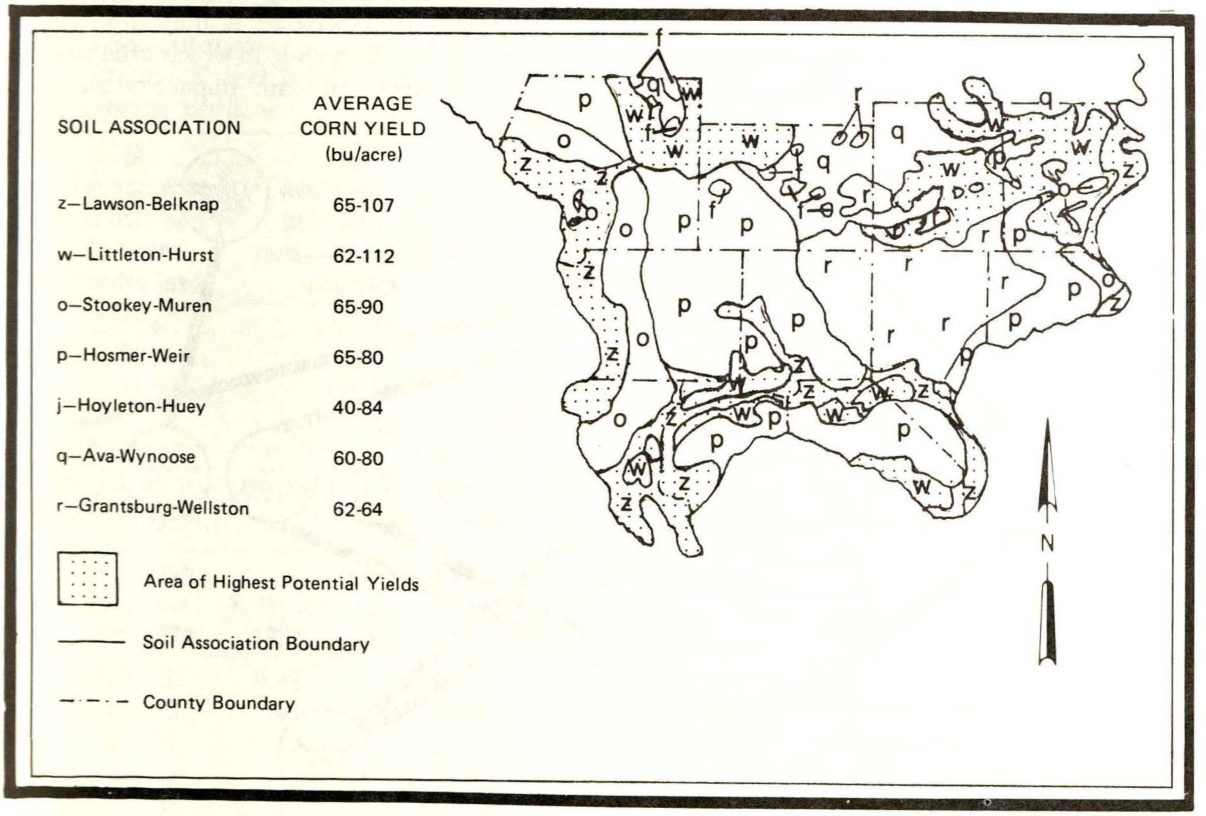

Figure 8. — *Major soil associations in the study region (Anonymous 1967).*

Figure 9 shows the linkages of various factors to individual variables (> 0.40 loading). Positive and negative signs indicate the nature of the relation between variable and factor. The most important observation that emerges from this diagram is the relative independence of the National Forest factor from the web of interrelations among the other factors.

EFFECT OF THE SHAWNEE NATIONAL FOREST ON COUNTY REVENUES

One of the chief criticisms leveled against the Forest Service in southern Illinois (and elsewhere) is that the tax immunity of Federal land causes substantial property tax losses to counties. To determine the impact of the Shawnee National Forest on county revenues, we used a stratified comparison of several counties based on the most recent year for which data could be assembled.[3]

[3]*Data taken from "National Forest Contributions to Local Governments, 1952", and "National Forest Contributions to Local Governments, 1962". These USDA Forest Service reports were national in scope and involved sampling of counties throughout the United States. Jackson and Pope Counties were the sample counties for Illinois (and the Shawnee National Forest) in both reports.*

Five counties were selected on the basis of two criteria: (1) degree of urban activity as identified by factor one in the preceding analysis, and (2) degree of influence of the National Forest as indicated by the percentage of county area in National Forest. Counties having more than 10 percent of their area in National Forest were considered high-intensity National Forest counties, while those having less than 10 percent were considered low-intensity. Selection of the latter criterion was based on a 10.8 percent average county area in National Forest for the entire study period.

The five Counties selected were Johnson, Pope, Massac, Union, and Jackson. Johnson and Pope Counties may be classed as rural counties according to the prior analysis. Johnson is a low-intensity National Forest county with 7.9 percent of its area in national forest (1972), and Pope is a high-intensity county with 34.6 percent of its area in that use. Massac and Union Counties are semi-rural counties with 1.9 and 13.2 percent of their areas in national forest, respectively. The final County, Jackson, is an urban county with 11.8 percent of its area in national forest, putting it in the high-intensity class. This County was selected for comparison because it indicates, as will be shown later, the degree to which urbanization offsets any large economic impact of the National Forest.

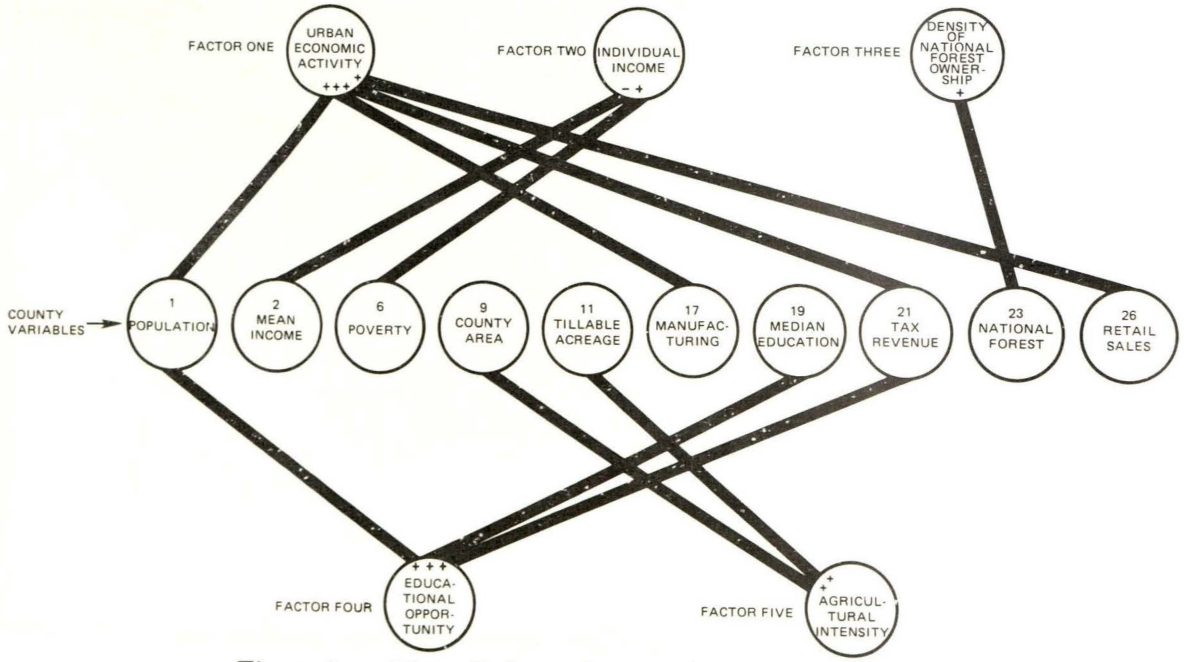

Figure 9. — *Major linkages between factors and variables.*

As a first step, a ratio between average price paid for farmland and average price paid for national forest land was established for the five counties. These data were compiled from 1954-1969 census of agriculture information and from USDA Forest Service records (table 4).

The expected market value of Forest Service land in each county (table 5) was determined by multiplying the average 1972 value per acre of farmland in each county by the ratio. This calculation assumes differences in land values for the same types of land under varying intensities of demand (caused primarily by various levels of population and economic activity in each county). It also makes two other implicit assumptions. The first is that the presence of national forest itself does not significantly affect the prevailing rural land prices. The second is that this current expected market value reflects generally the current value of all national forest land in a particular county.

Under these assumptions, the expected market value of USDA Forest Service land may be used to calculate estimated tax losses. This was done two ways to produce a high and low range of tax loss in each county. The first method used the letter of the law for property tax assessment in Illinois in 1972: 100 percent of "fair cash value", which is defined as 50 percent of the actual market value of such property, "not at forced sale or auction" (Anon. 1972). The second method, which yielded lower figures, was based on a ratio between average market values in table 6 and average dollar assessments per acre from previous USDA Forest Service reports. This ratio was calculated at 41 percent of current market value.

Table 4. — *Ratio of average purchase prices of National Forest land to average farm prices per acre*

Year	(A) Average price per acre paid for Forest Service land	(B) Average price paid for farm land—five sample counties	A/B ratio
1972	$112.90	$262.55	0.43
1969	84.70	228.95	.27
1959	37.52	144.30	.26
1954	11.47	60.37	.19

Table 5. — *Expected market values of National Forest land, 1972*

County	Average farm value per acre, 1972	Ratio for 1972	Expected value per acre of national forest land, 1972
Pope	$205.00	0.43	$ 88.15
Johnson	251.36	.43	108.08
Massac	267.37	.43	114.97
Union	265.24	.43	114.05
Jackson	326.38	.43	140.34

These two assessment ratios were incorporated into a final calculation for each county to estimate the range of tax loss in each case, as follows:

Total National Forest acreage in county (1972)	×	Expected market value	×	One of the two assessment ratios	×	County tax rate (1972)	=	Total tax loss

Total tax loss may be then divided by the national forest acreage to produce the average tax loss per acre (tables 6 and 7).

The highest tax losses per acre occur with increasing urbanization, because increasing population increases the cost of all land and tends to raise tax rates and assessments. However, the impact is greater in rural counties because alternative forms of wealth are largely absent and total revenues are much lower. In the most extreme case, Pope County, little taxable property exists other than land. The factor maps show an overlap of low economic and agricultural activity that contributes to a high dependence on land as the chief source of wealth in this county. As urbanization and economic growth take place, rural land becomes less important in generating tax dollars.

To complete this analysis a comparison must be made between apparent tax losses and revenue-sharing payments and in-kind benefits accruing to the counties. In-kind benefits have in the past been considered to be those costs that would otherwise be borne by the counties. This definition has been broadened somewhat in this analysis to include some costs that the counties might not have been able to bear themselves. However, these costs are direct benefits to the counties and the criterion is that the counties could conceivably have borne them. These in-kind benefits are represented by expenditures in four categories:[4] (1) cooperative

[4]*Source: Forms 6500-90 Geographic Ratio of Federal Outlays, compiled 2/23/74 for fiscal year 1973. These forms depict the funds expended by the Shawnee National Forest according to the county for various types of appropriations.*

Table 6. — *Assessment of National Forest land at 50 percent of expected market value, 1972*

County type	County	National Forest acreage	1972 estimated tax loss	Estimated loss per acre
Rural/high NF	Pope	81,493	$32,326	$0.40
Rural/low NF	Johnson	16,564	5,639	.34
Semi-rural/high NF	Union	33,735	15,582	.46
Semi-rural/low NF	Massac	2,995	1,567	.52
Urban/high NF	Jackson	39,995	22,452	.56

Table 7. — *Assessment of National Forest land at 41 percent of expected market value, 1972*

County type	County	National Forest acreage	1972 estimated tax loss	Estimated loss per acre
Rural/high NF	Pope	81,493	$26,508	$0.32
Rural/low NF	Johnson	16,564	4,624	.27
Semi-rural/high NF	Union	33,735	12,777	.37
Semi-ruralow NF	Massac	2,995	1,285	.42
Urban/high NF	Jackson	39,995	18,410	.46

law enforcement, (2) forest roads and trails, (3) water resource development, and (4) pollution abatement.

These expenditures for the five-county sample were made during fiscal year 1973. This is the same period during which tax monies from 1972 were being expended, and so are comparable on that basis. In addition, revenue-sharing payments made under the Weeks Law of 1911 are shown as direct financial benefits. Table 8 shows a comparison between these benefits and the calculated tax losses.

It is apparent from this table that shared revenues generally amount to less than half of estimated tax losses. However, as past studies have shown (EBS Management Consultants 1968), the addition of in-kind benefits generally tips the balance of benefits positively. The five-county average shows a comfortable $0.42 to $0.50 per acre of net benefits accruing to the counties over and above apparent tax losses. Tax losses of $1.00 per acre (Callahan *et al.* 1974) are not supported by our analysis. On a county-by-county basis, however, a greater pattern of inequity emerges. Massac County shows a negative net benefit (a net loss) of

Table 8. — *Comparison of estimated tax losses and net revenues accruing to counties as a result of National Forest ownership, 1972*

County type	County	Estimated 1972 tax loss per acre (low-high Range)	Weeks Law revenue payment per acre, 1972	In-kind benefits per acre	Net benefits (Col. 2+3 -1)
		1	2	3	4
Rural/high NF	Pope	32-40¢	15.4¢	31.6¢	+7 to 15¢ p/acre
Rural/low NF	Johnson	27-34¢	15.4¢	$1.08	+89 to 96¢
Semi-rural/ high-NF	Union	37-46¢	15.4¢	$1.07	+76 to 85¢
Semi-rural/ low-NF	Massac	42-52¢	15.4¢	.00	−(26.6 to 36.6¢)
Urban/high NF	Jackson	46-56¢	15.4¢	$1.14	+73 to 83¢
Five-county average		37-45¢	15.4¢	$71.6	+42 to 50¢

$0.27 to $0.37 per acre. The low national forest acreage in this county prevents this from being a serious loss. At its highest range this loss amounts to only 0.001 percent of Massac County's total revenues for 1972. The low margin in Pope County is more serious. The variability of revenue-sharing payments in conjuction with variable expenditures on in-kind benefits would certainly make it conceivable that net benefits could at times dip below zero, lending some support to the notion that tax losses do take place from time to time. However, the magnitude of the losses would be very small, since some form of revenue sharing always takes place. The sub-marginal nature of Pope County's economy (as shown by the factor analysis) certainly indicates that every effort should be made to avoid further stress to its economy. But claims of excessive tax losses on a regular basis appear to be unfounded. The remaining three counties show substantial positive net benefits because of high expenditures by the Forest Service on in-kind benefits.

CONCLUSIONS AND RECOMMENDATIONS

To clarify the conclusions that can be drawn from the preceding analysis, it is necessary to restate the hypotheses that were tested:

1. The socioeconomic structure of southern Illinois is sufficiently homogeneous to be analyzed systematically.
2. The Shawnee National Forest has a significant effect on the socioeconomic structure of the region.
3. The Shawnee National Forest has a negative effect on individual welfare, regional economic welfare, and local governmental welfare.

The results of the factor analysis demonstrate that the first hypothesis can be accepted. The socioeconomic structure of the region can be organized into a model of major socioeconomic relations or dimensions. When these are put into visual form they help to explain and simplify the existing socioeconomic structure.

The analysis refutes the second hypothesis, in that no significant relations, either positive or negative, were found that would suggest the Shawnee National Forest has any major effect on the socioeconomic structure of the region.

Hypothesis three is dependent on the outcome stated above, and is therefore also negative.

THE RELATION OF THE SHAWNEE NATIONAL FOREST TO THE ECONOMY OF SOUTHERN ILLINOIS

Two major conclusions may be drawn from the results stated above. First and most important, the evidence does not support the contention that the Shawnee National Forest has a negative impact on the economy of southern Illinois. Second, no evidence was found to support the assertion that large revenue losses to county government take place as a result of the tax immunity of Forest Service land. The results of the factor analysis further demonstrate that the association of large amounts of national forest with low levels of economic activity in particular areas generally arise out of common economic conditions. The national forest has a structural relation to marginal economies. This relation appears to be based on the fact that in less active economies, land use tends to be less intensive. This results in cheap land predisposed towards extensive use such as national forest. Thus, low levels of public and private economic welfare are not caused by the national forest.

Large areas of southern Illinois have throughout their history been considered to be economically marginal (Soady 1965). This was the situation when the Forest Service entered the region in 1933, and it has changed only moderately since that time. Soady (1965) and Callahan *et al.* (1974) suggest that the Forest Service entered the region for two purposes: to stabilize the management of land that had been severely exploited and misused for most of its history, and to stimulate the economy of a depressed region and stabilize land tenure and property tax forfeiture, which was rampant in southern Illinois during the Depression. The first purpose has largely been accomplished. The indications of this study are that the second has met with only limited success.

At present the Forest Service is only a neutral factor in the economy of the region. There has been little change in the relative standing of individual

counties in regard to wealth or economic viability since the Forest Service entered in 1933. Figure 10 shows a graph of total assessed valuations of five sample counties from 1913 through 1972. Counties that had the lowest values in 1913 have continued in that trend, with the exception of Massac. The difference in wealth between the economically viable counties and the marginal ones has grown greater in each year. Extreme disparity in urban economic activity, job opportunities, agricultural opportunity, and distribution of resources remain the overriding factors in determining economic well-being in southern Illinois. It can be stated with some certainty that in many ways the national forest has been a stabilizing force in the region. Certainly the contribution of the Shawnee National Forest toward establishment of productive land use and in providing recreation benefits, water resource development, and fish and wildlife management have immensely improved the environment of the region. However, the net effect of the forest on economic development, so sorely needed, has been only moderate at best.

The coincidence of Forest Service land with marginal economies in particular areas has hurt the public image of the Forest Service somewhat.

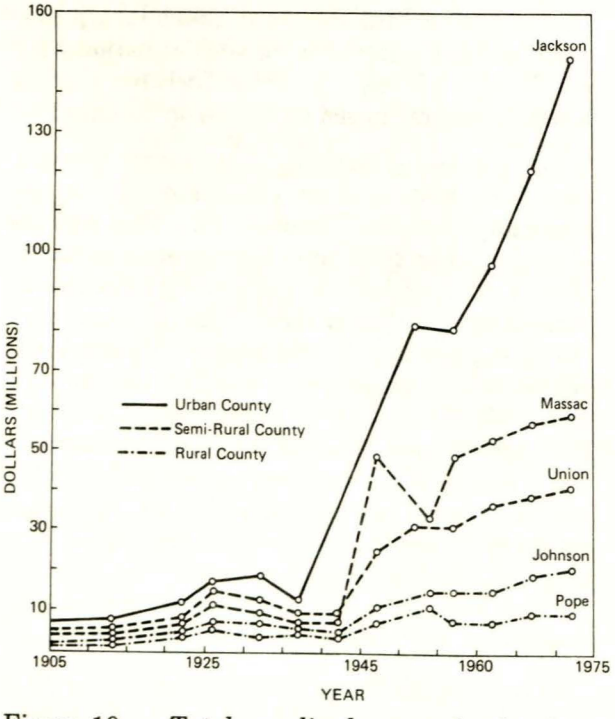

Figure 10. — *Total equalized assessed valuations of the five sample counties.*

However, the extensive land management practiced by the Forest Service makes this type of relation almost inevitable. This relation, more than anything else, probably leads the public to the conclusion that the National Forest somehow hurts the economy of southern Illinois. However, reviewing the history of the region and systematically analyzing its present condition leads one to the conclusion that the economy of the region would be no better off if the Forest were not present, and in some ways might be worse off.

The location of the Forest in relation to areas of low economic activity is inextricably woven into the problem of revenue sharing and property taxes. Lack of urban economic activity has been identified as the overriding factor in determining the viability of county government. Pope County, which has been the focal point for the tax immunity controversy in the region, reflects this problem in its most extreme state. It is evident that when significant or even moderate amounts of alternative wealth exist in a particular county, large amounts of public land make little difference to the viability of county government. The best examples of this are Jackson, Union, and Williamson Counties. The high correlation shown between urban economic activity and taxes make this factor the overriding predictor of local government welfare. Certainly the low level of individual and public welfare found in Pulaski County, which lies completely outside the purchase area, lends much credence to this explanation.

If the present revenue-sharing and in-kind benefit system has any problem at all, it lies in its inherent inflexibility. Shared revenue has been shown to amount to less than half of potential taxes in all cases for which estimates were made. These funds represent the only contribution to local government made by the Forest Service over which the State and County have any degree of control. Even this flexibility was, in the past, hampered to a large degree by the practice of "earmarking" funds for specific uses (EBS Management Consultant 1968)[5]. The high variability of expenditures that result in in-kind benefits to the

[5]*The report states (p. 67) that only 1.5 percent of section 10 land payments (which include Forest Service land) were shared without Federal restriction on their use. In 1966, 98 percent of such funds were ear-marked for roads and schools.*

counties further complicate the problem, since the management policies of the Forest dictate where those funds must be expended.

Expenditures per capita on social services have risen very sharply in the more marginal counties of the study region. This is illustrated by comparing low-income Pope County with Jackson County (fig. 11). In spite of the generally positive margin of benefits to the study region resulting from the Forest Service presence, the inflexibility of the revenue-sharing system makes problems such as this very difficult for local government to deal with.

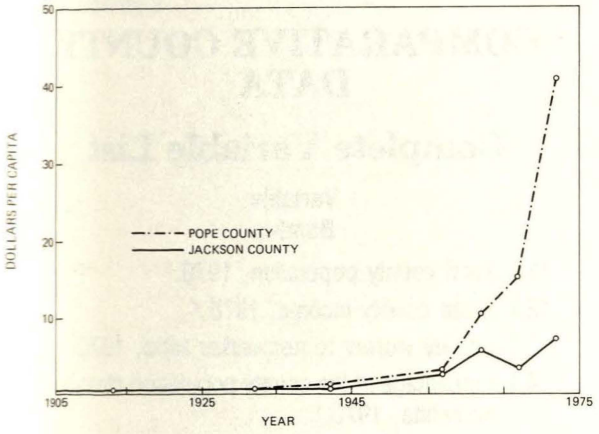

Figure 11. — *Expenditures on social services (U.S. Census of Government and county records).*

THE ROLE OF THE FOREST SERVICE IN REGIONAL ECONOMIC DEVELOPMENT

The Forest Service is increasingly being forced by legislative and public pressure to act as a funnel for aid to rural, economically depressed regions. Federal water resource projects have already gone through this evolution (Haveman 1965). The present system of revenue-sharing is based on the productivity of land in each management unit. Legislative proposals which seek to replace this system with minimum payments or some other system of payments in lieu of taxes will inevitably move the Forest Service in the direction of becoming a local agent of the Federal government for promoting regional economic development, perhaps at the expense of more efficient means of accomplishing the same end. Certainly a movement in this direction would require drastic changes in the objectives of the Forest Service.

A real question remains as to whether the Forest Service, whose activity is to produce public goods for the collective welfare of the Nation, should be placed in a position where it is held accountable to regional welfare and subjected to constant scrutiny in this regard. This type of accountability has led inevitably to a pressure within the Service to behave like a private corporation in generating revenue. On many National Forests such as the Shawnee, conditions are not conducive to high revenue generating activities. However, the furor over apparent harm to the local economy as a result of the low revenues often obscures the benefits of environmental enhancement, recreation, wildlife, and water production, which are outside of the normal market structure.

The drift of current legislation and public sentiment seems to be toward a more active role by the Forest Service in regional economic development and local government support. Perhaps the time has come for the Forest Service to develop one of three policies. It may take the initiative and attempt to structure this trend in a manner that best fits its existing goals and objectives of enhancing national welfare — a middle course. Or it may restructure its goals, policies, and administration to actively embrace coordinated regional development and local support. Or it may wish to carefully reshape its policy to avoid more extended involvement in regional development and monetary transfers to various local governments.

In any event, it seems fairly certain that some policy research planning relative to these alternatives is desirable if the Forest Service is to be prepared to best serve the national interest.

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APPENDIX A

COMPARATIVE COUNTY DATA

Complete Variable List

Variable Number

*1.) Total county population, 1970.[1]

*2.) Mean county income, 1970.[1]

3.) County worker to nonworker ratio, 1970.[1]

4.) Percentage of the county population classified as nonwhite, 1970.[1]

5.) Percentage of the county work force employed outside the county, 1970.[1]

*6.) Percentage of the county population below the 1970 U.S. poverty level.[1]

7.) Percentage of the county work force employed in one of seven occupational categories:[1]
   a. Agriculture
   b. Mining
   c. Construction
   d. Manufacturing
   e. Transportation, Utilities
   f. Retail and Wholesale Sales
   g. Services

8.) County age distribution.[1]

*9.) County area in acres.[1]

10.) Number of urban places exceeding 2,500 in population in the county.[1]

*11.) Number of tillable acres in the county, 1969.[2]

12.) Number of operating mines in the county, 1972.[5]

13.) Number of reservoirs exceeding 500 acres in size in the county.[5]

14.) Number of interstate highway exchanges in the county.[5]

15.) Percentage of the county work force employed in state and federal jobs.[1]

16.) Deleted and replaced by variable 26.

*17.) Number of manufacturing plants employing more than 20 persons in the county, 1972.[3]

18.) Township or county commission government.[4]

*19.) Median school years completed by the county population, 1970.[1]

20.) Total school enrollment in the county, 1972.[4]

*21.) Total county tax revenues, 1972.[4]

22.) Number of county government employees.[4]

*23.) Percentage of the county area in National Forest.[5]

24.) Number of National Forest recreation sites in the county.[5]

25.) National Forest revenue sharing payment, 1974.[5]

*26.) Per capita retail sales in the county, 1972.[6]

Sources of Data

1. U.S. Census of Population, 1970
2. U.S. Census of Agriculture, 1969
3. U.S. Census of Manufacturing, 1972
4. U.S. Census of Government, 1972
5. U.S. Forest Service literature and maps
6. U.S. Census of Business, 1972

*Variables used in the factor analysis.

County Data Observations

Alexander		Gallatin		Hardin	
Variable Number	Observation	Variable Number	Observation	Variable Number	Observation
1	12,015	1	7,418	1	4,914
2	6,738	2	7,389	2	6,908
3	.31	3	.31	3	.31
4	28.1	4	NA	4	NA
5	13.2	5	15.6	5	9.6
6	31.2	6	16.3	6	23.7
7a	5.6	7a	15.2	7a	2.7
b	.82	b	11.2	b	25.0
c	5.7	c	6.2	c	6.2
d	15.9	d	17.6	d	9.5
e	11.0	e	3.6	e	8.4
f	23.9	f	18.2	f	16.0
g	37.1	g	28.2	g	30.3
8a	13.8	8a	15.8	8a	14.3
b	6.1	b	5.1	b	5.1
c	12.1	c	9.1	c	11.0
d	7.6	d	11.3	d	7.4
e	17.5	e	22.0	e	20.9
f	25.4	f	23.0	f	25.7
g	17.5	g	13.7	g	15.6
9	143,360	9	209,920	9	117,119
10	1	10	0	10	0
11	62,738	11	135,776	11	31,822
12	2	12	44	12	14
13	1	13	0	13	0
14	0	14	0	14	0
15	16.3	15	14.6	15	31.9
16	deleted	16	deleted	16	deleted
17	7	17	4	17	1
18	no	18	yes	18	no
19	9.4	19	9.2	19	8.8
20	2,838	20	1,725	20	1,066
21	394,000	21	218,000	21	144,000
22	NA	22	52	22	27
23	18.7	23	5.1	23	19.9
24	1	24	2	24	4
25	2,551.74	25	1,014.94	25	2,209.76
26	2,179	26	1,328	26	1,106

Variable Number	Jackson Observation	Variable Number	Johnson Observation	Variable Number	Massac Observation
1	55,008	1	7,550	1	13,889
2	9,196	2	7,372	2	7,770
3	.36	3	.32	3	.33
4	7.2	4	NA	4	6.8
5	8.4	5	25.6	5	18.0
6	14.1	6	17.4	6	17.6
7a	3.7	7a	10.1	7a	8.7
b	.75	b	2.7	b	.54
c	5.4	c	13.0	c	7.7
d	12.0	d	14.4	d	22.6
e	5.9	e	8.3	e	11.6
f	17.7	f	17.1	f	19.8
g	54.5	g	34.3	g	29.2
8a	12.0	8a	11.8	8a	13.6
b	4.0	b	5.8	b	5.9
c	7.9	c	10.5	c	10.6
d	32.5	d	12.5	d	20.9
e	19.0	e	21.4	e	22.0
f	15.5	f	21.8	f	13.1
g	9.1	g	16.2	g	13.9
9	384,815	9	220,626	9	157,440
10	2	10	0	10	1
11	164,546	11	78,094	11	80,862
12	3	12	0	12	3
13	2	13	1	13	1
14	0	14	4	14	1
15	36.9	15	29.3	15	14.6
16	deleted	16	deleted	16	deleted
17	11	17	1	17	5
18	yes	18	no	18	no
19	12.1	19	8.8	19	9.9
20	9,040	20	768	20	3,577
21	1,194,000	21	90,000	21	538,000
22	NA	22	NA	22	56
23	11.8	23	34.6	23	1.9
24	6	24	4	24	0
25	3,913.51	25	7,956.84	25	284.59
26	2,133	26	1,176	26	1,636

Pope		Pulaski		Saline	
Variable Number	Observation	Variable Number	Observation	Variable Number	Observation
1	3,857	1	8,741	1	25,721
2	6,248	2	5,963	2	7,778
3	.25	3	.29	3	.32
4	NA	4	32.0	4	2.7
5	33.3	5	27.4	5	15.7
6	29.3	6	35.7	6	19.3
7a	13.9	7a	12.1	7a	4.2
b	5.7	b	2.7	b	13.5
c	14.9	c	5.3	c	7.3
d	11.6	d	17.4	d	9.1
e	6.0	e	11.7	e	7.4
f	12.6	f	17.2	f	21.5
g	35.3	g	33.6	g	37.1
8a	11.1	8a	14.6	8a	13.0
b	5.7	b	6.6	b	4.8
c	13.4	c	13.8	c	10.0
d	9.0	d	7.6	d	8.3
e	17.1	e	16.9	e	20.4
f	25.7	f	23.4	f	24.9
g	18.0	g	17.1	g	18.6
9	242,080	9	130,560	9	245,759
10	0	10	0	10	2
11	56,828	11	68,908	11	124,872
12	2	12	0	12	33
13	0	13	0	13	0
14	0	14	2	14	0
15	26.8	15	19.9	15	18.3
16	deleted	16	deleted	16	deleted
17	0	17	3	17	4
18	no	18	no	18	yes
19	8.8	19	9.0	19	9.4
20	768	20	2,279	20	4,944
21	90,000	21	180,000	21	518,000
22	NA	22	46	22	35
23	34.6	23	0	23	5.2
24	4	24	0	24	0
25	7,956.84	25	0	25	1,214.49
26	1,176	26	956	26	2,121

Union

Variable Number	Observation
1	16,071
2	8,322
3	.36
4	NA
5	15.1
6	16.2
7a	10.2
b	.90
c	8.9
d	18.2
e	6.8
f	16.3
g	38.7
8a	12.9
b	4.6
c	9.7
d	8.5
e	21.3
f	26.2
g	16.8
9	264,788
10	1
11	103,694
12	2
13	0
14	3
15	28.0
16	deleted
17	7
18	no
19	9.1
20	3,088
21	337,000
22	60
23	13.2
24	5
25	3,327.98
26	1,575

Williamson

Variable Number	Observation
1	49,021
2	8,351
3	.35
4	1.6
5	21.0
6	14.1
7a	1.0
b	7.0
c	7.6
d	21.9
e	7.4
f	20.3
g	33.9
8a	14.2
b	5.5
c	10.2
d	10.0
e	22.8
f	23.1
g	14.2
9	282,228
10	4
11	68,616
12	16
13	4
14	4
15	19.2
16	deleted
17	13
18	no
19	11.3
20	10,600
21	1,396,000
22	107
23	.12
24	0
25	30.89
26	2,301

APPENDIX B

STATISTICAL ANALYSIS USED IN THE STUDY

Spearman Rank Correlation and Partial Correlation Analysis

Once initial visual and graphic analysis had been completed on the county data, 17 variables were chosen to be used in Spearman correlation analysis. Spearman correlation is a nonparametric technique that correlates the ranks of observation on each variable against their rank on other variables. Spearman correlation has a high power efficiency (0.91) to standard Pearson correlation and is an effective substitute where the number of observations on each variable is small. It is based on the formula (Siegel 1956):

$$R_s = 1 - 6^{d2}(n^3 - n)$$

where n is the number of observations and the d's are the differences between ranks for each observation measured on variables X and Y.

A correction factor must be used to remove the effect of ties in the rankings. The formula when corrected for ties is as follows:

$$r_s = \frac{\left(\frac{n^3-n}{12} - \Sigma T_x\right) + \left(\frac{n^3-n}{12} - \Sigma T_y\right) - \Sigma d^2}{\sqrt[2]{\left(\frac{n^3-n}{12} - \Sigma T_x\right)\left(\frac{n^3-n}{12} - \Sigma T_y\right)}}$$

where T is the number of ties in each ranking. The results of this analysis are presented on the next page (table 1).

Eight of the variables listed in table 1 were eliminated for use in the factor analysis (See Appendix A for complete variable list). Variables 3, 20, 24, and 25 were found to be interchangeable measures or functions of other variables through partial correlation analysis. Variables 5, 12, and 15 had comparatively low correlations with the remaining variables and so served little useful function in seeking a systematic construct. Variable 16 was replaced by variable 26 because the latter was thought to be a better measure of the same attribute.

Table 1. *Spearman Rank Intercorrelation matrix of selected variables*

	V_1	V_2	V_3	V_5	V_6	V_9	V_{11}	V_{12}	V_{15}	V_{16}	V_{17}	V_{19}	V_{20}	V_{21}	V_{23}	V_{24}	V_{25}
V_1	1.0																
V_2	.81	1.0															
V_3	.82	.93	1.0														
V_5	−.33	−.44	−.43	1.0													
V_6	−.58	−.91	−.83	.31	1.0												
V_9	.66	.79	.68	−.04	−.77	1.0											
V_{11}	.55	.64	.56	−.28	−.58	.52	1.0										
V_{12}	.21	.50	.20	−.37	−.40	.20	.31	1.0									
V_{15}	.01	.11	.20	−.21	−.19	.24	−.11	−.36	1.0								
V_{16}	.34	.30	.19	−.07	−.22	.21	.50	.40	−.59	1.0							
V_{17}	.86	.74	.74	−.46	−.61	.53	.41	.29	−.17	.33	1.0						
V_{19}	.77	.71	.72	−.19	−.64	.54	.51	.19	−.10	.42	.71	1.0					
V_{20}	.97	.79	.76	−.27	−.56	.60	.51	.35	−.17	.39	.88	.78	1.0				
V_{21}	.90	.76	.71	−.38	−.54	.49	.45	.47	−.27	.39	.91	.78	.96	1.0			
V_{23}	−.39	−.20	−.18	.03	−.37	−.15	−.47	−.15	−.45	−.35	−.31	−.42	−.50	−.26	1.0		

Other variables that do not appear in the Spearman correlation were used only as informational variables for comparative analysis and in most cases were not suitable for meaningful statistical analysis. (See Appendix A).

Factor Analysis

The 10 variables selected in the above analysis were next analyzed using a Rao's Canonical factor analysis. The Canonical factor analysis model is based on the Maximum Likelihood Factor Model developed by Lawley (1940). Canonical factor analysis follows the common factor model in that it attempts to account for common variance among the variables. Unlike common factor analysis, which determines common factors by factoring the correlation matrix with estimates of the communalities in the diagonal, canonical factor analysis determines the common factor estimates (loadings) which have the highest canonical correlation with the variables. Harris (1962) says that if a population of cases is involved or may be assumed, significance tests need not be applied. The communality value will be the squared multiple correlation for each variable and the appropriate number of factors will be those with eigen values greater or equal to 1. This was the assumption made in this analysis and final factor selection was made on that basis.

Canonical factor analysis rescales the correlation matrix by the unique parts of the data. Therefore, variables which have the largest part of their variance in common play the largest role in estimating a particular factor space (Rummel 1970). To most clearly delineate the factors identified, the axis of each sould be rotated to find the best "fit" of loadings to the factor. This is done to find the most uncluttered loadings on each factor or its "simple structure" so it may be more easily identified (Beazley and Holland 1973). One of the goals here is to reduce as many loadings as possible to zero or near zero. Two types of rotation may be used, orthogonal and oblique. Orthogonal rotation maintains independence between factors, or more precisely, the reference vectors representing the factors are maintained at 90 degrees to one another. Oblique rotation (the method used in this analysis) allows the axis of the factor to be rotated independently without reference to orthogonality or independence among factors. Oblique rotation has two advantages for this type of study. First, it generally produces factors that are less cluttered and easier to understand (Cattel 1952). Second, because the factors can be expected to be intercorrelated, the factors are more accurate representations of reality; one would not expect to find factors completely independent of one another, as they are by definition in the orthogonal rotation. This ability to correlate the factors identified sometimes sheds further light on the character and relationship of the factors (as it did in this study).

The final step in this factor analysis was the generation of factor scores on the data cases, or more precisely, composite factor score estimates. When principal-components analysis is used, these factor scores are exact; however, with other methods of factor analysis, such as the canonical one used here, the factor scores are estimates because the factors themselves are estimates. The method used in this analysis was the Complete Estimation Method outlined by Harman (1967). Factor scores in this method are derived from the factor-score coefficient matrix, F, which is derived from the formula:

$$F = S^t R^{-1},$$

where S is the rotated factor structure matrix and R is the correlation matrix. Finally, a composite scale of factor scores of each variable contributing to the factor is constructed. These columns of factor scores are multiplied by a vector of standardized scores on each data case for the variables analyzed. Thus:

$$f_1 = F_{px1} z_n,$$

where f_1 is the factor score of case one on factor one, F_{px1} is a column vector of the factor-score matrix representing factor one, and z_n is the factor of standardized scores of the data case (thus z_1 would equal the observation of the data case on variable 1 minus the mean of variable 1 divided by the standard deviation of variable 1).

The resultant factor scores on each county are shown in table 2. These factor scores were used to map the theoretical distribution of each factor (see Appendix C).

All the preceding statistical procdures were accomplished with the aid of the Statistical Package for the Social Sciences and the IBM 370 computer at Southern Illinois University, Carbondale.

Table 2. *Composite factor score estimates on county observations*

County name	F_1	F_2	F_3	F_4	F_5
Alexander	−0.305120	1.57906	0.175935	−0.503038	−.0893898
Gallatin	−.469591	−.259754	−.703234	−.957866	.769215
Hardin	−.870766	.310784	.312913	.559750	−1.534380
Jackson	1.570994	−1.338387	.061290	2.024730	1.957957
Johnson	−.948708	−.378441	.061215	−.261693	.005022
Massac	−.025608	−.503883	−1.164662	−. 227486	−.500794
Pope	−1.074966	1.110172	2.348356	−.022760	−.580330
Pulaski	−.642147	1.854515	−.896805	−.471423	−.489248
Saline	−.100847	.315961	−.369071	.112164	.771990
Union	.309991	−.814474	.650498	−.875386	.700261
Williamson	1.946526	−.822488	−.476451	1.742540	−.204787

APPENDIX C

SYMAP PROCEDURES USED FOR FACTOR MAPS

SYMAP is a computer package created by the Laboratory for Computer Graphics and Spatial Analysis at the Harvard Center for Environmental Design Studies, Harvard University. Version five was utilized in this study.

To generate the computer-based maps shown in the factor analysis results, composite factor score estimates were derived for each county observation on each factor (this procedure is explained in Appendix B). These factor scores were then used to map the intensity of the factors in each county, using the scores as data values placed at subjectively selected points in the county depending on the characteristics of the factor.

The SYMAP program utilized four sets of information. The A-outline package delineates the outline of the study region. This outline is constructed by defining vertices on a coordinate system. Their locations are based on the same coordinate system. Next, the corresponding data values for each data point are read in the E-values package. Finally the F map package defines the options that will be taken in regard to map format and data treatment.

The maps produced for this study are statistical contour maps with isolines connecting areas of equal values. The shape of these areas is controlled strictly by the placement of data points (a subjective judgment) and options chosen in data treatment. The program divides the data values into a number of equal or unequal ranges (depending on the user's need), and then interpolates the isolines between data points using a minimum of four and a maximum of 10 data points within a specified search radius. In generating these maps the standard options were taken.

In all cases except in mapping the National Forest factor, the data point chosen for each county observation was the point of highest population. In all cases except one this was the county seat. The only exception was Jackson County, where Carbondale is considerably larger than the county seat, Murphysboro. The data points for the National Forest factor were placed inside the Purchase Area Boundary in the area of heaviest Forest Service ownership. In addition, three dummy data points were added on this particular factor map to prevent large spill-overs resulting from interpolation problems at the edges of the study area.

A question may be raised as to why population centers were used in mapping factor five, agricultural intensity. One must remember that the factor, as identified in this analysis, is primarily an economic one; therefore, by placing the data point in the population center for the county, it is also placed at the probable center of wealth in the county where its net effect would be most important.

A second question which might arise concerning this procedure is the exactness of the process in defining actual boundaries and area definition. First, and most important, isopleth maps of the type produced here have a tendency to smooth and blur distinct boundaries. Therefore, they are presented only as a general, visual tool in understanding the concepts presented. Second, the interpolation does not define fixed boundaries (such as the National Forest purchase area); this results in "spilling over", especially on the borders of the study region. The interpolation process becomes more exact as the number of data points increases; however, the observational net was fairly large, thus, the distributions presented are quite general and should not be viewed as absolute in any sense.

County boundaries, purchase area boundaries, county names, and other relevant information have been added to make the maps more readable. The following two pages display a typical input of data used to generate a factor map.

```
//EXEC LIBRARY,RUN=SYMAP,REGION.LIBRARY=180K
FORMS=-)A,2,4021*-//LIBRARY SYSIN DD*
A-OUTLINE
 1.    5.    20.   27.   14.    9.
 1.   15.    19.   24.   11.    8.
 3.   15.    18.   22.   12.    7.
 3.   24.    18.   18.    7.    7.
 2.   24.    18.   17.    6.    6.
 2.   37.    19.   15.    5.    4.
 3.   38.    20.   15.    4.    3.
 4.   37.    21.   15.    3.    4.
 5.   39.    23.   15.    2.    5.
 6.   38.    23.   13.    1.    5.
 7.   36.    20.   12.
 8.   36.    21.   12.
 9.   37.    22.   12.
10.   38.    21.   11.
11.   38.    22.   12.
12.   34.    21.   10.
13.   33.    19.   10.
14.   29.    18.    9.
15.   29.    17.    8.
16.   29.    16.    8.
17.   30.    16.    8.
20.   29.    15.    7.
B-DATA POINTS
 10.   10.
  9.   34.
  9.   17.
  9.   27.
 12.   21.
 12.   32.
 12.   10.
 12.   27.
 17.   10.
 18.   16.
 17.   25.
  5.   14.
 21.   11.
  5.   36.
99999
E-VALUES
  0.061290
 -0.259754
 -0.476451
 -0.369071
  0.061215
  0.312913
  0.650498
  2.348356
  0.175935
 -0.896805
 -1.164662
 -0.500000
 -0.500000
 -0.500000
99999
F-MAP=X
C
C
C
  1    9.    12.
  2    1.    1.    24.    39.
  3    4.
 14    0.5   0.5   0.5    0.5
 26
99999
999999
/*
//
```

☆ U.S. Government Printing Office: 1979—667-796/76 Region No. 6

Spencer, David, and Ronald I. Beazley.
1979. The economic and geographic impact of national forest land on counties in southern Illinois. U.S. Dep. Agric. For. Serv., Res. Pap. NC-172, 27 p. U.S. Dep. Agric. For. Serv., North Cent. For. Exp. Stn., St. Paul, Minnesota.

Analyzes the impact of the Shawnee National Forest on the socio-economic structure of 11 counties in southern Illinois. Includes a factor analysis model as well as an assessment of tax losses to local government as a result of the National Forest.

OXFORD: 906(73). KEY WORDS: property taxes, factor analysis, public land, revenue sharing, marginal agriculture, local government, Shawnee National Forest.

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